Scand J Prim Health Care 1989: 7/33–8

Environmental Risk Factors for Otitis Media with Effusion in Preschool Children

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Zielhuis GA, Heuvelmans-Heinen EW, Rach GH, van den Broek P. Environmental Risk Factors for Otitis Media with Effusion in Preschool Children. Scand J Prim Health Care 1989: 7: 33–8.

To ascertain risk factors for otitis media with effusion (OME), a cohort of 1439 preschool children, 2 years of age, was investigated by means of tympanometry at 3-monthly intervals until their fourth birthday. Parents were asked about potential risk factors for OME. Data were analysed in a case-control design with incident cases. Age, season, family size, siblings's history of OME, frequent swimming, duration of breast feeding and public day care appear to have a significant effect on OME, even after adjustment for nasal infection. Gender, race, birth weight and passive smoking were not related to OME incidence. With the exception of age and season, the relative risks of environmental factors for OME are always very low. It is concluded that the study of environmental risk factors for OME is necessary to increase the knowledge of the nature of this disease, but that it does not contribute much to medical care at the moment.

Key words: otitis media with effusion, secretory otitis media, epidemiology, risk factors, preschool children.

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INTRODUCTION

Otitis media with effusion (OME = secretory otitis media = glue ear) is one of the commonest diseases in childhood and is responsible for most of the hearing losses in this age group (1–3). Because of its silent nature – the disease remains unnoticed on many occasions – those who come to the attention of a general practitioner, paediatrician, ENT surgeon, or a public health officer form only the tip of the iceberg (4). OME has been studied world-wide, with respect to its epidemiology, natural course, diagnosis, sequelae, treatment, and risk factors.

Studying risk factors for OME is important for several reasons. First, it can give clues to the better understanding of the aetiology of the disease. This may indicate possibilities for (primary) prevention. Second, if screening is considered for OME, knowledge of risk factors may lead to the definition of high-risk groups, which should receive priority in such a screening programme. And third, knowledge of risk factors may help doctors (GPs and others) to make a diagnosis. Such information might help to complete the clinical picture and lead to a valid diagnosis of OME.

A large amount has been written about risk factors for OME. The effect of upper respiratory tract (URT) infections on tubal function and middle ear status is widely documented and no object for dispute. Children with pathology of the URT, such as simple rhinitis, run an increased risk of developing OME (5–7). The prognostic value is much less clear for the other (environmental) risk factors. Studies on this topic often give contradictory results, perhaps because of methodological shortcomings, such as invalid measurements, small sample sizes, and lack of correction for interdependencies between risk factors.

In reviewing epidemiological studies that meet some basic scientific standards (i.e. tympanometry

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measurement or pneumatic otoscopy, sufficient sample size, no overt bias), we can list ten risk factors:

- *Age*. The prevalence of OME at birth is assumed to be zero. The occurrence starts to rise after 6 months, and reaches a maximum at about two years of age. The prevalence then decreases, with a small elevation at about five years. From the age of seven, OME is relatively rare. Exposure to respiratory infections is thought to be related to this typical age structure (8–10).
- *Gender*. Many studies (11, 12), but not all (5), have found a higher prevalence of OME in boys. Again this difference could be related to differences in genetic susceptibility to infections (13).
- *Race*. Some specific populations, such as Eskimos, Indians, gypsies, and Australian Aboriginals are known to have higher prevalences of OME (14–16). This predominance can partly be explained by socio-hygienic conditions. Shurin et al (17) found that white children are three times more susceptible to persistent OME than black children. This can partly be explained by the higher level of medical observation and therefore the greater chance of detection in white children.
- *Family characteristics*. Family size is probably not a major risk factor for OME (18). There is conflicting data on the relevance of a family history of ear diseases or atopic diseases (5, 18, 19). There is no agreement about the importance of socio-economic status as a risk indicator for OME. If an effect exists, it is probably not due to malnourishment (5, 20) but to poor housing conditions and crowding (21).
- *Pregnancy and lactation*. Although many studies (22) show a relation between the way an infant is fed (breast/bottle) and respiratory illness the evidence for an effect of feeding practice on OME is scanty and conflicting (18, 23). The same is true for birth weight and prematurity as risk indicators for OME (24, 25).
- *Season and climate*. Higher incidences in cold seasons have been widely described (11, 24), but there is only scant evidence that specific climatic conditions are responsible for this seasonable variation.
- *Swimming*. Although it has been put forward as a risk factor, swimming has not proved to be an important prognostic factor (25).
- *Public day care*. A considerable amount of evidence on the frequency of OME has been published on the effect of exposure to other children (8, 26–28). Again, this effect could be explained by respiratory infections.
- *Passive smoking*. There is little evidence that parental smoking has an effect on the risk for OME, but the literature is not consistent (24, 29).
- *Constitution and congenital abnormalities*. Children with Down's syndrome, cleft palate, or Kartagener's syndrome are more at risk for OME compared with children without these congenital defects (15, 30).

  The literature on the risk for OME in children with atopic constitution or allergy is inconclusive (5, 18, 19).

This review of the limited evidence available on risk factors for OME calls for further studies that cope with methodological fallacies. The present paper describes a large-scale epidemiological study on the prevalence of OME in preschool children, in which the various possible risk factors have been investigated.

POPULATION AND METHODS

The KNOOP project is a large-scale epidemiological study on the natural history of OME in preschool children, performed in the city of Nijmegen. All children born between 1 September 1982 and 31 August 1983 and living in Nijmegen on their second birthday were included. The group comprised 1439 children, from whose parents permission to take part in the study was sought. Tympanometry (Grason Stadler-27) was performed at three-monthly intervals, from the children's second birth-day until four years of age. All measurements were carried out by trained audiological assistants at the children's home address. The tympanograms of all ears were classified into four types (modification of Jerger 1970).

type A : maximum compliance ≥0.2 ml at a middle ear pressure -99 to +200 dPa
type C1: maximum compliance ≥0.2 ml at a middle ear pressure -199 to -100 dPa
type C2: maximum compliance ≥0.2 ml at a middle ear pressure -399 to -200 dPa
type B: maximum compliance <0.2 ml or at a middle ear pressure ≤-400 dPa.

Type B indicates the presence of middle ear effusion. At each of the nine consecutive tympanometric

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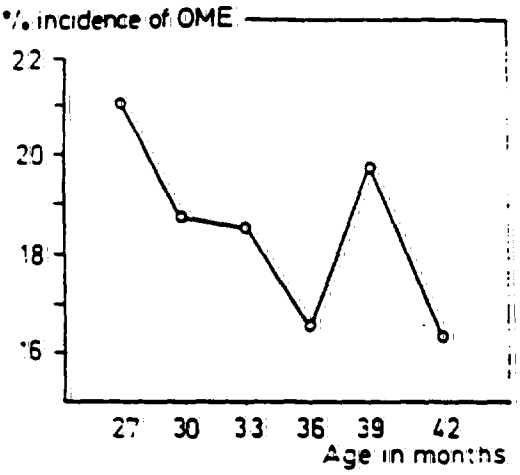

Fig. 1. Relation between age and the 3-monthly incidence of OME. Results of the KNOOP project.

screenings, the parents were asked about potentially relevant events during the three previous months, including possible risk factors for OME.

To study the effect of the factors on the risk for OME, we selected incidence data with reference to all children who did not have a type B tympanogram at a particular screening. Children in this group were considered to be patients when at least one ear showed a type B tympanogram at the next screening. The control group consisted of children with a type A tympanogram in both ears, or a combination of type A and type C1 tympanograms at this latter screening. These two groups form the basis for a case-control analysis.

Regarding family characteristics, passive smoking, type of day care, and swimming, we selected incidence data from the screening session in which the parents were asked about these factors, i.e. when the children were 27, 30, 36 and 42 months of age, respectively (sessions 2, 3, 5 and 7, respectively).

To study the effect of age, we included the data from all screening sessions until the age of 42 months. The percentage of children with at least one B tympanogram at a particular session was calculated from all children without a type B tympanogram at the former screening.

Incidence data on the other risk factors were collected at the age of 42 months. This approach is based on the assumption that risk-factor information collected at other ages will give valid estimates of the status at 42 months of age. The relative risk for all risk factors was estimated by means of an odds ratio (OR) with a 95 % confidence interval (CI). Hypotheses of elevated risk ratios were tested by means of the chi-square test. A stratified analysis was performed to take URT infections into account as a confounder, in situations where the OR was significantly above unity. Stratification was performed by dividing the study population into two groups: one group in which the children had had a serious nasal infection during the previous three months and a second which had not.

RESULTS

Figure 1 shows the relation between age and the three-monthly incidence of children with OME (= type B tympanogram). A bimodal curve with one peak at the age of 27 months and another at 39 months can be seen.

Patients and controls did not differ significantly with respect to the distribution of race, parental history of OM, breast feeding, gestation period, birth weight, and smoking by household members (Table 1). However, the following factors seem to bear a pertinent relation to the occurrence of OME.

The longer a child had been breast fed, the less the risk for OME. This trend appeared to be significant ($p < 0.05$). The risk for OME in boys was 1.6 times higher than in girls.

Family size and a history of OME in siblings were significantly related to the incidence of OME.

Season was an important factor in the aetiology of OME. With the summer as reference point, the highest risk for OME was found in winter, the smallest elevated risk in spring.

No overall association between swimming and OME could be found. Only frequent swimming, at least once a week, showed an elevated risk for OME. There was no linear trend for the frequency of swimming.

Attending public day care enhanced the occurrence of OME, but there was no linear trend in the effect of time spent at public day care.

Ten children in this study population suffered from congenital pathology of very diverse origins, and its role in the aetiology could not therefore be established.

Nasal infection appeared to be a confounder of all the significant risk factors mentioned above. After adjustment for nasal infection, all other risk factors remained (see Table 1). The confounder effect was strongest for public day care.

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Table 1. *Risk factors for OME, with and without correction for upper respiratory tract infections.*

Environmental risk factors	No. of cases	No. of contr.	OR	p	OR*	p*
gender (m/f)	117	386	1.50	0.055	-	-
race (European/not European)	116	368	1.75	0.219	-	-
family size (1, 2, ≥3 children)	140	354	-	0.010	-	0.012
parental history OME (y/n)	140	354	0.80	0.303	-	-
siblings history OME (y/n)	140	354	1.85	0.005	1.66	0.024
breast feeding (n/y)	115	366	0.71	0.187	-	-
duration of breast feeding						
(0–4 wks/2–3 m/4–6 m/≥7 m)	86	250	-	0.176	-	-
2–3 months/0–4 weeks	35	136	1.07	0.865	-	-
4–6 months/0–4 weeks	37	110	0.64	0.234	-	-
≥7 months/0–4 weeks	46	124	0.57	0.113	-	-
gestation period						
(≥38 weeks/<38 weeks)	117	386	0.74	0.354	-	-
birth weight						
(≤2500 gr/>2500 grams)	114	382	161	0.190	-	-
season						
autumn/winter/spring/summer	117	386	-	0.000	-	0.017
spring/summer	42	208	2.35	0.012	1.61	0.184
autumn/summer	47	215	2.59	0.004	2.19	0.019
winter/summer	60	209	3.93	0.000	2.84	0.002
swimming (last 3 months)						
(no/1–3×/4–11×/≥12×)	117	345	-	0.068	-	-
≥1×/no	117	345	1.14	0.552	-	-
1–3×/no	82	248	1.14	0.640	-	-
4–11×no	72	245	0.70	0.275	-	-
≥12×/no	79	216	1.94	0.034	2.38	0.009
public day care						
(y/n)	122	337	1.88	0.007	1.71	0.023
no. of half days a week						
(1–2/3–4/≥5)	122	393	-	0.003	-	0.348
3–4/1–2	80	188	1.11	0.711	-	-
≥5/1–2	89	320	0.50	0.004	0.73	0.207
smoking by household members (y/n)	128	307	1.11	0.643	-	-
no. of cigarettes per day						
(0/1–7/8–17/18–27/≥28)	127	304	-	0.274	-	-
8–17/1–7	44	76	1.24	0.509	-	-
18–27/1–7	32	89	0.60	0.236	-	-
≥28/1–7	30	71	0.76	0.527	-	-

* Corrected for nasal infection by means of the method of Mantel and Haenszel in case the crude odds ratio was significantly ($p < 0.05$) above unity.

DISCUSSION

Of all the environmental risk factors studied, only a few appeared to have a significant effect on OME: age, season, family size, sibling's history of OM, frequent swimming, and public day care.

The literature also suggests a bimodal curve for the prevalence of OME according to age (10), but in the curve we found (using incidence data) the second peak occurred at an earlier age. This indicates a faster rate of normalization of OME at about the age of 39 months. The development of the Eustachian tube and the level of maturity of the immune system may explain this.

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Our finding that the highest rates of OME occurred during winter, and the lowest during the summer is in agreement with previous studies (9, 11). After adjustment for common colds, there was still a significant relationship between season and OME, but only for autumn and winter seasons. In the context of the KNOOP-project, the connection between OME and weather conditions has been studied (31). Low temperatures and few hours of sunlight appeared to be relevant factors.

According to the literature, the family history of OME (parents or siblings) is predictive for the occurrence of OME. Our data, however, showed only a significant relation with family size and history of OM in siblings. Our implication of the type of day care in the aetiology of OME agrees with other authors (8, 26–28). However, the trend in our study for the more time children are exposed to other children, the more they develop OME, was not significant. All these results seem to indicate that OME is a contagious disease.

It was shown by Ishidoya et al (25), as in our project, that swimming was not an important risk factor. Only frequent swimming, at least once a week, showed some effect in our data. More studies, which consider the swimming environment and the type of swimming water as well, are necessary to establish the specific effect of swimming behaviour.

In spite of our criticism of other studies in the introduction, we did not perform multivariate analyses. But, due to the design of the study, age and season are uniformly distributed among the other factors. The other risk factors we found to be significant are independent of each other on account of their nature.

It is generally accepted that URT infections play an important role in the pathogenesis of OME and therefore are a potential confounder in risk factor analyses. Surprisingly, we found that the effect of risk factors on the incidence of OME remained significant after correction for URT infections. However, it should be noted that we adjusted for nasal infection in the preceding three months, before a case of OME was diagnosed. This may have caused some misclassification and thereby incorrect confounder control.

That we could not find a significant effect for the remaining risk factors does not necessarily mean that they have no effect on OME. Further in-depth studies, in which a direct relationship between nasal infections and OME must be taken into account, are necessary to clarify the effect of these factors on OME.

It should be noted that the relative risks of environmental risk factors, with the exception of age and season, were always very low, though sometimes significant. This has relevance in the context of preventive and clinical practice.

- With such low relative risks, it is impossible to reduce the OME incidence substantially by means of (primary) prevention. Moreover, these factors do not lend themselves to intervention strategies.
- If a screening program for OME is considered, it should be realized that the risk factors found do not lead to a clear definition of high-risk groups, i.e. groups that contain most of the OME cases.
- In the context of OME diagnosis, knowledge of risk factors has a low predictive value. The only environmental factors strong enough to justify inclusion in medical decisions are age and season.

This means that studying environmental risk factors for OME is mainly a scientific activity that could help to increase our knowledge of the nature of the disease, without making a significant contribution to medical care at the moment.

ACKNOWLEDGEMENT

The authors wish to thank Mr. M. 't Hart for conducting the computer analyses.

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Received August 1988.
Accepted November 1988.

2023380878

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